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ABSTRACT

Results of an analysis of a newly developed spelling test and several related measures are reported. Information about the reliability of a newly developed spelling test; its distribution of scores; its relationship with the standard battery of aptitude tests of the Johnson O'Connor Research Foundation; and its relationships with sex, age, education, college major, and laterality were studied using a sample of clients of the Johnson O'Connor Research Foundation (clients seeking information about aptitudes for career and educational planning). A total of 1,080 adult examinees completed at least part of the spelling measures. Measurement precision appears excellent for the new measure. The strongest relationships for spelling ability were with English vocabulary, reading efficiency, number checking, age, and years of education. Sex differences were found, although there was little indication of relationships with examinee laterality or parental handedness. Correlation with English vocabulary was substantially greater than correlations with other standard battery measures. Although there may be distinct aptitudes or other dispositions that affect spelling ability, spelling itself appears to be a learned skill and not an inherent aptitude. Seventeen tables present study findings, and four figures illustrate score distributions and the age curve for ability. (Contains 88 references.) (SLD)

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THE SPELLING PROJECT

Kathy E. Green

and

David H. Schroeder

JOHNSON O'CONNOR RESEARCH FOUNDATION, INC.

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The Spelling Project

Kathy E. Green and David H. Schroeder

ABSTRACT

This report presents the results of an analysis of a newly developed spelling test and several related measures. Previous reports by Wyatt (1968, 1969) discuss earlier Foundation research on spelling. The present report provides information regarding the reliability of the new spelling test, its distribution of scores, its relationships with the standard Foundation battery of aptitude tests, and its relationships with sex, age, education, college major, and laterality. Particular attention is paid to the relationships of spelling ability with English vocabulary and graphoria. To summarize, measurement precision (reliability) appears excellent for the new spelling test. The strongest relationships for spelling ability were with English Vocabulary, Reading Efficiency, Number Checking, age, and years of education. As expected, sex differences were found, though there was little indication of relationships with examinee laterality or parental handedness. The correlation with English Vocabulary was substantially greater than the correlations with other standard battery measures. Although there may be distinct aptitudes or other dispositions that affect spelling ability (graphoria in particular), spelling itself appears to be a learned skill and not an inherent aptitude.

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BACKGROUND AND PURPOSE OF THE STUDY

Spelling, as part of written communication, is an important component of literacy in our society. Spelling, as a skill, has been researched since the late 1800s in conjunction with the study of reading skills. The Foundation has been interested in spelling for some time. Questions of interest to the Foundation include whether improvements in spelling ability are found with increasing age, the extent to which spelling is related to vocabulary knowledge, and whether the ability to spell English words is primarily an acquired skill or an aptitude.

Investigation into the nature of spelling has taken different lines. One line of inquiry is the study of how people learn to spell. Current thought suggests that teachable cognitive strategies govern correct spelling (Read & Hodges, 1982). A second line of inquiry is the study of spelling in persons with neurophysiological brain dysfunctions. The method of investigation typically involves examination of persons with brain injuries. Studies suggest that the capacity to spell is accessed via a direct visual information-spelling route and an indirect auditory information-spelling route (Conte, Samuels, & Zirk, 1983). Fehring (1983) suggests that in normal adults, spelling involves the utilization of a combination of visual and auditory information. If damage to one hemisphere occurs, one channel may be less operative, and the individual may rely more on the other channel. There is some suggestion that lateralization or incomplete lateralization affects spelling ability, although the findings are inconsistent.

A third line of inquiry addresses relationships between auditory and visual discrimination ability and spelling. Visual discrimination has been found to relate to spelling ability (Day & Wedell, 1972; Templeton, 1980; Williamson, 1933a). Auditory discrimination also has been found to correlate with spelling (Day & Wedell, 1972; Groff, 1968). Simon and Simon (1973) argue that phonological information is used to generate spellings, while visual information is used in word recognition. Sweeney and Rourke (1978) suggest that different abilities are differentially important at different stages of learning to spell.

A final line of inquiry in spelling is the investigation of rule-based versus rote spelling. There is some suggestion that rote spelling leads to superior performance when contrasted with spelling by rule (Baron et al., 1980; Sloboda, 1980). The rule-rote dichotomy is termed the Phoenician-Chinese distinction. Phoenician (rule) spellers make more errors and different types of spelling errors than Chinese (rote) spellers. Differences between these two types of spellers could arise through varied experience with written and spoken language, through differences

in brain development, or through some general tendency to view parts versus wholes.

Additional research in spelling concerns sex differences and heritability. Sex differences are evident in the incidence of both reading and spelling disabilities, with more males evidencing problems than females (Finucci & Childs, 1981; Hier, 1981; Traxler, 1948). The etiology of these differences is unclear. Kiefer and Sangren (1925) note a relationship between spelling ability and family history of spelling problems, but Stafford (1963) found that the pattern of relationships of spelling abilities within families failed to fit a sex-linked genetic model.

Numerous correlational studies have been conducted relating spelling ability to a score of variables. Table 1 presents a summary of studies that correlated spelling with other variables. Correlations with IQ range from .04 to .60, with a median of approximately .42. This relationship seems to be significant, though moderate, for both children and adults. Persons with low IQs are likely to be poor spellers, but high intelligence does not guarantee superior spelling ability (Russell, 1937; Terman, 1925). Spache (1941a) suggested a tendency for the relationship between spelling ability and IQ to decrease with age (median *r* for Grades 1-4 of .56, median *r* for Grades 5+ of .50). Spelling ability also has been found to be significantly related to reading ability (comprehension and speed) for both children and adults. These correlations range from .27 to .91, with a median of approximately .60. Spelling ability has been found to relate to vocabulary knowledge at about the same level, with correlations ranging from .47 to .70, with an approximate median of .61. The relationship between spelling and spelling vocabulary--knowledge of the meanings of the words that are to be spelled--has not been frequently investigated previously. Spelling ability seems to improve with age; the spelling ability of females is significantly higher than that of males.

Both visual and auditory perceptual abilities have been found to be significantly related to spelling accuracy, although the correlations vary with the test used. It has not been established whether lack of perceptual skill predisposes one to spelling failure, whether it is coincidental or causal, or in fact, whether the tests used are valid measures.

Few personality variables have been found to correlate at a significant level with spelling ability. Those that have correlated significantly did so at a low level (*rs* < .30). Motivational factors have been cited by a number of researchers as a potential major cause of poor spelling (Carmen, 1900; Foran, 1934; Hendrickson & Pechstein, 1926; Kiefer & Sangren, 1925; Murray, 1919; Russell, 1937; Traxler, 1948; Williamson, 1933a). Carelessness in observing words, a lack of concern with spelling,

Table 1

Correlations Between Spelling Ability and Other Measures

Source	Measure	Age/grade[a]	*N*	*r*
	CORRELATIONS WITH SPELLING ABILITY (*N* = PERSONS)			
General intelligence				
Wallin, 1967	General IQ	3rd grade boys	186	.52-.54**
		girls	190	.50-.52**
"	Raven's Matrices	boys	186	.23-.24**
		girls	190	.21-.25**
Glogauer, 1977	IQ	4,5,8th grades	418	.37-.48**
Russell, 1937	IQ	3-5th grades	NA	.27-.39**
Russell, 1955	Primary Mental Abilities:	5-6th grades	250	
	Perception			.29**
	Reasoning			.51**
	Spatial			.14*
	Total			.58**
Spache, 1941a	IQ	elementary	NA	.44[b]**
Battle & Labercane, 1982	IQ--WISC-R Verbal	2-9th grades	124	.21*
	Performance			.17
	Full-Scale			.21*
Starkman et al., 1976	IQ--WISC Similarities	7th gr boys	79	.04
	CTMM Verbal			.55**
	CTMM Quantitative			.52**
	CTMM Total			.57**
Gates, 1922	IQ	3-8th grades	135	.31**
		3-7th grades	234	.41**
Hollingsworth, 1918	IQ	5th grade	15	.31
Houser, 1915	IQ	4-8th grades	186	.53**
Schonell, 1934	Verbal IQ	9-14 yrs	249	.55**
Williamson, 1933a	Mental age	8th grade	34	.60**
Holmes, 1959	IQ	college men	42	.50**
		college women	59	.52**
Schonell, 1934	IQ	18-22 yrs	82	.19
Williamson, 1933a	Army Alpha	college males	150	.17*
Williamson, 1933b	College aptitude	h.s. srs	53	.72**
Murray, 1919	IQ	college	NA	.42
Holmes, 1954	Quantitative IQ	college	91	.21*
	Linguistic IQ			.53**
	Total IQ			.45**
Holmes, 1959	Analytical reasoning	college men	485	.22**
		women	1114	.16**

Note. "NA" means that the specified information was not available. "NS" means that the correlation was not significant, although the exact value was not available.

*$p < .05$. **$p < .01$.

[a]Age or grade level of the subjects of the study.

[b]This is the *median* correlation of 57 samples.

[c]This is the *median* correlation of 41 samples.

[d]This is the *median* correlation of 31 samples.

Table continues

Table 1 (cont'd)

Source	Measure	Age/grade[a]	*N*	*r*
Reading and other verbal ability measures				
Ehri & Wilce, 1982	Reading comprehension	7th grade	98	.41-.43**
		1-2nd grades	18	.67**
Phelan, 1929	Reading	4th grade	62	.67**
		5th grade	48	.64**
	Reading with perception partialled out	4th grade	62	.46-.48**
		5th grade	48	.51-.57**
Russell, 1955	Reading comprehension	5-6th grades	250	.45**
Townsend, 1947	Reading	3rd grade	200	.47**
		4th grade	197	.68**
		5th grade	197	.61**
		6th grade	209	.57**
		7th grade	207	.57**
		8th grade	201	.50**
		9th grade	214	.51**
		10th grade	214	.51**
		11th grade	231	.46**
		12th grade	190	.48**
Wallin, 1967	Reading speed	3rd grade		
		boys	186	.62-.67**
		girls	190	.62**
Spache, 1941b	Reading	elementary	NA	.62[c]**
Battle & Labercane, 1982	Reading	2-9th grades	124	.91**
Starkman et al., 1976	Reading	7th gr boys	79	.83**
Ehri & Wilce, 1982	Reading comprehension	college	88	.30*
Hartmann, 1931	Silent reading	college	636	.47**
	Hidden word identification	"	"	.27**
	Letter-digit substitution	"	"	.41**
	Pronunciation	"	"	.58**
Wallin, 1967		3rd grade		
	Anagrams	boys	186	.51-.52**
		girls	190	.49-.52**
	Word identification	boys	186	.39-.43**
		girls	190	.40-.43**
	Mutilated words	boys	186	.52-.60**
		girls	190	.48-.59**
Williamson, 1933a	Ability to define words	4-8th grades	NA	.62
	Ability to use words	college	150	.55**
Groff, 1968	Phonetics	NA	NA	NA

Note. "NA" means that the specified information was not available. "NS" means that the correlation was not significant, although the exact value was not available.

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Table continues

Table 1 (cont'd)

Source	Measure	Age/grade[a]	*N*	*r*
Groff, 1984	Word familiarity	4th grade	381	.20**
Peake, 1940	Spelling vocabulary (identification of word meanings)	4th	41	.93**
			17	.81**
		5th grade	35	.68**
			15	.83**
		6th grade	49	.75**
			24	.87**
		7th grade	63	.62**
			24	.43*
		8th grade	54	.57**
			33	.63**
		4-8th grades	355	.81**
Townsend, 1947	Vocabulary	3rd grade	200	.59**
		4th grade	197	.67**
		5th grade	197	.60**
		6th grade	209	.61**
		7th grade	207	.59**
		8th grade	201	.58**
		9th grade	214	.66**
		10th grade	214	.67**
		11th grade	231	.65**
		12th grade	190	.70**
Russell, 1955	Vocabulary	5-6th grades	250	.60**
Spache, 1941a	Vocabulary	elementary	NA	.61[d]**
Williamson, 1933b	Vocabulary	h.s. srs	53	.72**
Visual/auditory abilities				
Hartmann, 1931	Perceptual span	college	636	.78**
	Visual recognition	"	"	.39**
Phelan, 1929	Word perception (9 tests)	4-5th grades	110	.01-.78
Gates, 1922	Word perception with IQ partialled out	3-8th grades	135	.54**
Russell, 1937	Visual perception	3-5th grades	NA	.55
Russell, 1955	Visual perception	5-6th grades	250	.50**
Wallach, 1963	Perceptual recognition	elem grades	NA	.47
	Perceptual recognition with IQ, reading, English grades, and arithmetic partialled out	elem grades	NA	.23

Note. "NA" means that the specified information was not available. "NS" means that the correlation was not significant, although the exact value was not available.

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[c]This is the *median* correlation of 41 samples.

[d]This is the *median* correlation of 31 samples.

Table continues

Table 1 (cont'd)

Source	Measure	Age/grade[a]	*N*	*r*
Wallin, 1967	Visual perception--	3rd grade		
	syllables	boys	186	.36-.44**
		girls	190	.53-.55**
	words	boys	186	.56-.57**
		girls	190	.65**
	Figural perception	boys	186	.12-.17
		girls	190	.01-.06
Kiefer & Sangren, 1925	Rote visual memory	NA	NA	.57
Battle & Labercane, 1982	Visual memory-association	2-9th grades	124	.69-.72**
Hartmann, 1931	Auditory memory-digit span	college	636	.15**
	Auditory recognition			.43**
Russell, 1955	Auditory perception	5-6th grades	250	.54**
	Visual perception			.50**
	Auditory + visual score			.66**
Wallin, 1967	Sound discrimination	3rd grade		
		boys	186	.33-.44**
		girls	190	.38-.41**
Starkman et al., 1976	Digit span	7th grade	79	.25
Holmes, 1954	Phonetic association	high school	227	.73**
		college	102	.64**
	Tonal memory	high school	227	.30**
		college	91	.18-.34
	Sound quality discrim.	high school	227	.10
	Sound intensity discrim.	high school	227	.19**
		college	91	.20-.23
	Tonal movement	high school	227	.43**
	Time discrimination	high school	227	.15
		college	91	.10-.16
	Rhythm discrimination	high school	227	.34**
		college	91	.01-.19
	Pitch discrimination	high school	227	.33**
		college	91	.14-.29
	Melodic taste	high school	227	.15
Bailey, 1977	Vocal rhythm	3rd grade	66	NA*
	Auditory sequencing	3rd grade	66	NA*

Note. "NA" means that the specified information was not available. "NS" means that the correlation was not significant, although the exact value was not available.

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[c]This is the *median* correlation of 41 samples.

[d]This is the *median* correlation of 31 samples.

Table continues

Table 1 (cont'd)

Source	Measure	Age/grade[a]	*N*	*r*
Personality				
Holmes, 1959	Nervousness	college men	43	.33*
		women	87	-.15
	Depression	men	43	.27
			42	.36
		women	87	-.05
			59	.13
	Criticalness	men	43	.24
		women	87	.17
	Activity	men	43	.03
		women	87	.20
	Paranoia	men	42	.22
		women	59	-.01
	Hysteria	men	42	.02
		women	59	.19
	Psychopathic deviance	men	42	.37*
		women	59	.26*
Cox, 1978	Sensitization-Repression (scored for sensitization)	college	80	NA*
Other measures				
Murray, 1919	College grades	college	204	.42**
	English grades	college srs	74	.59**
		college jrs	74	.52**
Starkman et al., 1976	Arithmetic	7th grade	79	.45**
Battle & Labercane, 1982	Arithmetic	2-9th grades	124	.70**
	Errors on Bender-Gestalt test	NA	NA	-.47**
Bannatyne & Wichiarajote, 1969	Ambidexterity	3rd grade	50	.42**
Williamson, 1933a	Handwriting	NA	NA	.18
Hendrickson & Pechstein, 1926	Spelling consciousness	college women	67	.68**
Van Ondenhoven et al., 1984	Social class	3rd grade	NA	NA*
Bittman, 1979	Social class	3rd grade	220	NA*
Walker, 1974	Sex (scored toward females)	college	146	NA**
Cox, 1978	"	college	80	NA**
Stafford, 1963	"	h.s., adult	234	NS
Wallin, 1967	"	3rd grade	376	NS
Spache, 1941b	"	elem grades	NA	NS

Note. "NA" means that the specified information was not available. "NS" means that the correlation was not significant, although the exact value was not available.

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[c]This is the *median* correlation of 41 samples.

[d]This is the *median* correlation of 31 samples.

Table continues

Table 1 (cont'd)

Source	Measure	Age/grade[a]	*N*	*r*
Hunt & Randhawa, 1980	Successive processing	4-5th grades	165	.39**
	Simultaneous processing			.27**
	Attention			.35**
Kiefer & Sangren, 1925	Perseveration	NA	NA	.71
	Speed of decision-making			.98*
	CORRELATIONS WITH TYPE OF SPELLING ERROR (*N* = PERSONS)			
Finucci et al., 1983	IQ	NA	NA	NS
Goyen & Martin, 1977	Phonetic vs. nonphonetic errors	13-14 yrs	93	.93**
	CORRELATIONS WITH SPELLING DIFFICULTY, ACROSS WORDS (*N* = NO. WORDS)			
Bloomer, 1956	Grade level of word	2nd grade	75	.31**
Gates, 1937		elem grades	NA	NS
Bloomer, 1956	Word frequency	2nd grade	75	-.24
				-.18
Bloomer, 1961		elem grades	149	-.34**
Goyen & Martin, 1977		13-14 yrs	93	-.80**
Groff, 1968		2-4th grades	350	-.43**
Groff, 1984		2nd grade	810	-.49**
Mangieri & Baldwin, 1979		4,6,8th grades	180	-.58**
Bloomer, 1961	Log_2 frequency	elem grades	149	-.49**
Bloomer, 1964		elem grades	498	-.59**
Bloomer, 1956	Word length	2nd grade	75	.48**
Bloomer, 1961		elem grades	149	.57**
Bloomer, 1964		elem grades	498	.62**
Gates, 1937		adults	NA	.73
Williamson, 1933a		adults	NA	.73
Mangieri & Baldwin, 1979		4,6,8th grades	180	.57**
Bloomer, 1961	Number of word meanings	elem grades	149	-.29**
Bloomer, 1961	Concreteness	elem grades	149	-.20*
Bloomer, 1956	Meaningfulness	2nd grade	75	.15
Mangieri & Baldwin, 1979	Meaningfulness with frequency and length partialled out	4,6,8th grades	180	.55**
Kyte, 1958	Number of ways of misspelling word	intermediate grades	60	.48**
Bloomer, 1956	Sound discriminability	2nd grade	75	.47**
	Shape discriminability	2nd grade	75	.37**
Mangieri & Baldwin, 1979	Phonetic-graphemic regularity	4,6,8th grades	180	-.35
Bloomer, 1956	Pleasingness of word sound	elem grades	NA	NS
	Emotional intensity of word	elem grades	NA	NS

Note. "NA" means that the specified information was not available. "NS" means that the correlation was not significant, although the exact value was not available.

*$p < .05$. **$p < .01$.

[a]Age or grade level of the subjects of the study.

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failure to recognize when to use a dictionary, an attitude of fatalism, disregard of detail, and poor study habits may contribute to poor spelling.

Research on spelling conducted by the Johnson O'Connor Research Foundation began in 1956 with a study by Foley. Her interest was in assessing whether spelling was primarily an acquired skill or an aptitude. In relation to this, she was also interested in the relationship between vocabulary and spelling. In research by Foley (Technical Report 613), Ward (Technical Report 646), Kennedy (Technical Reports 688, 689, 690), and Wyatt (1968, 1969), it was found that spelling ability increased with age, and women scored better than men. Significant correlations were found with graphoria and English vocabulary. Subsequent work by Griffits, Gaston, and Peck (1971), Totman (1972), Behrendt and Holder (1973), Holder (1972, 1974), and Shambaugh and Holder (1974) suggested a nonlinear relationship between age and spelling and implicated a possible degree of heritability of spelling ability. Table 2 presents correlations from four studies of relationships between spelling ability and Foundation tests.

Table 3 presents a summary of studies that have assessed the reliabilities and validities of spelling measures. In general, these values indicate that people are being rank-ordered similarly by each of the various types of spelling tests, though the exact skill being measured may differ a little from one type to another. There is little evidence, however, that any one type of test yields a superior measure. The most frequently used type of spelling test is the oral word-list dictation test, in which the test administrator presents orally the words to be spelled. Other types of spelling tests consist of true-false spelling items, multiple-choice items, identification of spelling errors in written composition, sentence or story proofing with correction of misspelled words, and skeleton words that must be completed (e.g., qu_r__l [quarrel]). Reliabilities for spelling tests tend to be high, ranging from .56 to .98, though somewhat higher for list dictation tests than for other measures. Validities, typically assessed by correlation with either list dictation or the number of spelling errors in composition, have also generally been in an acceptable range (.45 to .96).

This report addresses the psychometric properties of several measures: a newly developed spelling test, a vocabulary test that accompanies the spelling test, and two self-rating measures constructed for this study. The major purposes of this study were to design and evaluate a new spelling test and to assess the relationships between spelling ability, vocabulary knowledge, and word familiarity and between spelling ability and the aptitudes assessed by the standard Foundation battery.

Table 2

Correlations of Spelling Ability With Other Foundation Measures

Measure	Study						
	TR 613[a]		Wyatt, 1968[b]			Griffitts et al., 1971[c]	Shambaugh & Holder, 1974[d]
	r_m	r_f	r_m	r_f	r_t	r	r
Number Checking	.44	.43				-.35	.38
Color Perception						.11	
Ideaphoria	.20	.14				.28	.17
Foresight						.02	.01
Inductive Reasoning						.09	-.03
Analytical Reasoning						.18	.18
Wiggly Block						.01	-.02
Paper Folding						.07	
Black Cube						-.13	.09
Structural Visualization						.04	
Personality, Objective						-.05 to +.05	.11
Tonal Memory						.23	.16
Pitch Discrimination						.16	.29
Rhythm Memory						.38	.24
Timbre Discrimination						.22	.07
Memory for Design	.05	.23				.14	.08
Silograms	.31	.52				.34	.20-.45
Number Memory	.28	.33					
Observation	.03	.12					
Finger Dexterity (right hand)						-.02	
Finger Dexterity (left)						-.09	
Tweezer Dexterity (right)						-.06	
Tweezer Dexterity (left)						-.14	
English Vocabulary	.52	.65	.48	.65	.55	.53	.53
age ≤ 18					.54		
age > 18					.52		
Spelling Vocabulary	.30	.59					
Proportion Appraisal							-.08
Grip (right hand)							-.15
Grip (left)							-.10
Syllable Memory						.28	
CAT VI						.18	
Age					.55		

Note. r_m = correlation for males; r_f = correlation for females; r_t = correlation for total sample.

[a]Used Wks. 541. *Ns* = 247 to 283 males, 72 to 83 females.

[b]Used Wks. 541G. *N* = 182 (96 males, 86 females).

[c]Used Wks. 541G. *N* = 200 males.

[d]Used Wks. 541G. *N* = 200 males.

Table 3

Reliabilities and Validities of Spelling Ability Tests

Source	Type of test	Age/grade	*N*	Relia.	Validity[a] List	Validity[a] Comp	No. words
Cook, 1932	List dictation	8th gr	465	.98	-	-	150
Croft, 1982	List dictation	3-4 gr	80	.90-.94	-	-	35
Freyberg, 1970	List dictation	11 yrs	506	.95	-	-	50
Goyen & Martin, 1977	List dictation	NA	NA	.97	-	-	50
Holmes, 1954	List dictation	college	91	.89	-	-	79
Nisbet, 1939	List dictation	10-11 yrs	80	.92 (test-retest)			25
Williamson, 1933b	List dictation	h.s. srs	53	.84-.92 (split-half) .56-.96 (test-retest)			40-50
Stafford, 1963	List dictation	h.s.,adult	234	.80-.89	-	-	NA
Brody, 1944	Sentence dictation	4th gr	179	-	.95	-	60
		5th gr	176	-	.93	-	60
		6th gr	174	-	.87	-	60
		7th gr	223	-	.95	-	60
		8th gr	244	-	.91	-	60
		9th gr	235	-	.91	-	60
Brody, 1944	Paragraph dictation	4th gr	179	-	.92	-	60
		5th gr	176	-	.86	-	60
		6th gr	174	-	.93	-	60
		7th gr	223	-	.96	-	60
		8th gr	244	-	.92	-	60
		9th gr	235	-	.91	-	60
Winch, 1918	Paragraph dictation	7 yrs	56	-	.90	-	19
Cook, 1932	Errors in composition	8th gr	465	.93	-	-	2000-word essay
Croft, 1982	Errors in prose	3-4 gr	80	.90-.95	.79	-	NA
Freyberg, 1970	Errors in prose	11 yrs	506	-	.72	-	30-min story
Cook, 1932	Multiple-choice	8th gr	465	-	.79	-	50
Croft, 1982	Multiple-choice	3-4th gr	80	.78-.90	-	.74	35
Freyberg, 1970	Multiple-choice	11 yrs	506	.93	.68	.85	46
Holmes, 1954	Multiple-choice	h.s.	227	.90	.82	-	35
		college	91	.76	-	-	50
Holmes, 1959	Multiple-choice	college	1599	-	.85	-	NA
Nisbet, 1939	Multiple-choice	10-11 yrs	80	-	.87	-	25

Note. "NA" means that the specified information was not available.

[a]Criteria are "List," which is spelling ability measured by a list dictation test, and "Comp," which is spelling ability measured by the number of errors made in an assigned composition.

Table continues

Table 3 (cont'd)

Source	Type of test	Age/grade	*N*	Relia.	Validity[a] List	Validity[a] Comp	No. words
Sturdyvin, 1937	Multiple-choice	college	320	-	.88	-	50
Wallin, 1967	Multiple-choice	3rd gr	-	-	.81	-	NA
Cook, 1932	Multiple-choice	8th gr	465	-	.80	.65	NA
Foran, 1934	Multiple-choice	6-8th gr	-	.76	-	-	NA
Phillips, 1931	Multiple-choice	college	-	-	.69	-	75
Cook, 1932	True-false	8th gr	465	-	.81	.69	50
Nisbet, 1939	True-false	10-11 yrs	80	-	.91	-	25
Cook, 1932	Sentence proofing and correction	8th gr	465	-	.84	.69	50 sentences
Croft, 1982	Proofing	3-4 gr	80	.91-.94	-	.80	3 paragraphs
Cook, 1932	Word proofing and correction	8th gr	465	-	.85	.63	50 sentences
Brody, 1944	Paragraph proofing	4th gr	179	-	.45	-	18 paragraphs
		5th gr	176	-	.46	-	
		6th gr	174	-	.70	-	
		7th gr	223	-	.75	-	
		8th gr	244	-	.73	-	
		9th gr	235	-	.71	-	
Nisbet, 1939	Skeleton words	10-11 yrs	80	-	.90	-	25
Williamson, 1933b	Esperanto words	h.s. srs	53	-	.89	-	60

Note. "NA" means that the specified information was not available.

[a]Criteria are "List," which is spelling ability measured by a list dictation test, and "Comp," which is spelling ability measured by the number of errors made in an assigned composition.

DEVELOPMENT OF EXPERIMENTAL MEASURES

As noted, several measures were developed for this project. The first was a test of ability to spell English words (Worksample 733 A*). This test consists of 125 four-option multiple-choice spelling items. The second instrument was a spelling vocabulary test (Worksample 734 A*). This test consists of 50 vocabulary items. The 50 test words were drawn from the 125 words on the spelling test. The items were selected from the Foundation's vocabulary item bank (Technical Report 1990-3), which includes *Wordbook* items, the Worksample 704 (executive vocabulary) items, the 708 series of experimental *Wordbook* items, and other items written and calibrated at the Foundation. No items from Worksamples 690 or 695 were used. The third instrument was a word familiarity questionnaire. This form asks examinees to rate their familiarity with the 50 words on the spelling vocabulary test (which were also on the spelling test) on 1 to 5 scales. The purpose of this instrument was to allow us to ascertain the relationships between perceived familiarity with particular words and knowledge of their spellings and meanings, respectively. In addition, at the end of the form, examinees are asked several questions regarding parental handedness, which outside research suggested might be related to spelling ability. The final instrument was a verbal-skill self-assessment measure. It consists of 14 items asking examinees to rate their own level of skill and the degree of importance they place on each of seven verbal skills.

ANALYSES TO BE PERFORMED

After analyzing the internal psychometric properties of the experimental measures, we performed a number of additional analyses to address the research questions for the study:

1. The difficulty order of spelling words and vocabulary words was examined for the entire sample and for subgroups.
2. The distributions of spelling scores for males and females were examined.
3. The relationship between age and spelling score was studied for males and females.
4. The relationships between spelling ability and eyedness, handedness, and parental handedness were examined.
5. The relationships between spelling ability and motivation to spell were examined for males and females.
6. The relationships between spelling ability and the Foundation's standard battery of tests were studied for males and females.
7. A principal components (factor) analysis of the standard battery tests with spelling was performed to determine whether

spelling loads on an auditory factor, a visual factor, or neither.

8. Finally, multiple regression was used to determine how well spelling could be predicted from the tests in the standard battery.

METHOD

Examinees

The examinees in this study were clients of the Johnson O'Connor Research Foundation who were tested in the Boston, New York, Atlanta, Tampa, Los Angeles, and San Diego offices during 1986 and 1987. These people came to the Foundation for testing to obtain information about their aptitudes useful in career and educational planning. They paid a fee for the testing. Examinee ages ranged from 14 to 77 (mean = 27); 48% were female, 52% male. Reported years of education ranged from 7 to 24. A total of 1,080 examinees completed at least part of the spelling measures. The sample was diverse with respect to both age and education although most examinees had attended college or were college-bound. Also, socioeconomically, examinees tended to be at least upper-middle class.

Procedures

Data collection began in the summer of 1986 and was completed in early 1987. The tests were given during breaks in the standard testing. The English spelling test was taken by the examinee and returned to the test administrator before the spelling vocabulary and word familiarity tests were given. The English spelling test was, then, completed by the end of the second appointment, and the spelling vocabulary and word familiarity tests were completed before the summary. The English spelling test took approximately 10 to 15 minutes; the remaining measures took about the same amount of time to complete.

Methods of Analysis

Dichotomous scoring was used with the English spelling test and the spelling vocabulary test. Spelling test items were analyzed using classical and Rasch-model approaches. The items selected for retention in the test were those that maximized reliability for the sample while providing reasonable fit to a Rasch model. Items were then analyzed separately for different subgroups (male, female, younger examinees, older examinees, and so on), and the order of items by logit (Rasch-model) difficulty was compared across groups.

The analyses were conducted separately for males and females. When differences were nonsignificant, the results were reported only for the combined sample. Further analyses included a principal components analysis (similar to factor analysis) of measures. Varimax rotation was used for multifactor solutions. Pearson product-moment correlations and stepwise regression analysis were employed to assess the magnitude of the relationships among variables. Differences in performance on the experimental measures in relation to sex, age, laterality, and vocabulary level were assessed using correlations, *t*-tests, and analyses of variance.

The .01 level was set as the acceptable probability of a Type I error. This level was used rather than .05 because of the relatively large number of cases available. The statistical package SPSS-X (SPSS Inc., 1986) was used to perform all analyses except for the Rasch item analyses, for which the program BICAL (Wright, Mead, & Bell, 1980) was used.

RESULTS

Measure Development

English spelling test. The analysis of this measure consisted of successively assessing internal-consistency (alpha) reliability and fit to the Rasch model for various item sets until the best item set was identified for the entire sample. The reliability for all 125 items was .92. Thirty-one items were subsequently deleted in three stages, yielding a total of 94 items with an internal-consistency reliability of .92. The 31 items were deleted because they misfit the Rasch model or they detracted from measure reliability. An additional four items were deleted because of inconsistency in rank orders for item difficulty when items were analyzed by subgroup. The internal-consistency reliability of the 90 remaining items was .92, which is very good. Item difficulties, item-total correlations, standard errors (of the logit difficulties), and fit statistics for deleted and retained items are presented in Table 4. The items are presented in ascending order of difficulty. The values for the deleted items were taken from the original analysis of all items; the values for the retained items were taken from the analysis of the final 90-item set. It should be noted that to achieve overall fit to the Rasch measurement model, some of the more-difficult items were deleted, as were items with relatively high item-total correlations. A total score summing correct responses to the 90-item set was calculated for each person.

The item-total correlations (corrected for item-total overlap) ranged from .01 to .46, with a median of .34. Some items that did not enhance overall reliability were retained

Table 4

Difficulty Indices, Item-Total Correlations, and Fit Statistics for Spelling Ability Items

	Item	*p*	Logit difficulty	Std error[a]	Item-total corr	Between fit	Total fit
3	because	1.00	-5.14	.71	.01	1.11	.23
22	oxygen	.99	-3.63	.34	.20	-.26	.01
46	system	.99	-3.43	.31	.09	-.45	.10
1	easily	.99	-3.26	.28	.18	.46	.02
2	decided	.98	-2.54	.20	.27	1.37	-.27
13	usage	.98	-2.50	.20	.23	1.76	-.19
33	faction	.98	-2.43	.19	.16	-1.24	.00
19	request	.97	-2.39	.19	.32	3.64	-.72
58	prejudicial	.98	-2.39	.18	.30	2.80	-.46
30	anxiety	.96	-1.96	.16	.30	1.92	-.71
28	scissors	.95	-1.75	.14	.31	.17	-.69
26	avert	.95	-1.73	.14	.20	2.60	-.74
48	schedule	.95	-1.69	.14	.22	-.03	-.34
45	principle	.95	-1.69	.14	.34	2.06	-.55
61	subtle	.93	-1.48	.13	.44	5.17	-1.84
4	counselor	.93	-1.48	.13	.33	2.05	-.92
39	barricade	.94	-1.46	.13	.34	2.37	-.92
53	leopard	.94	-1.43	.13	.38	3.20	-1.26
17	exhibit	.93	-1.38	.13	.25	.22	-.05
49	rhythm	.91	-1.18	.12	.29	.07	-.44
37	meager	.92	-1.09	.11	.29	.93	-.12
38	serene	.91	-1.03	.11	.43	4.73	-1.85
20	flannel	.91	-1.03	.11	.36	2.26	-.81
56	discriminate	.90	-.85	.10	.21	.36	.54
31	pious	.90	-.81	.10	.26	.56	-.30
36	bizarre	.89	-.81	.10	.35	.51	-1.01
27	pithy	.89	-.78	.10	.26	-.24	.29
65	license	.90	-.74	.10	.29	-.46	-.06
5	calendar	.87	-.70	.10	.34	.86	-.60
6	cafeteria	.87	-.60	.10	.40	2.28	-1.43
25	encumber	.87	-.59	.10	.30	.33	.01
18	receipt	.87	-.55	.09	.37	1.19	-1.25
72	askew	.87	-.55	.09	.37	1.95	-1.22
40	scour	.86	-.49	.09	.36	.39	-.62
66	jewelry	.84	-.47	.09	.39	2.42	-1.95
67	poignant	.86	-.47	.09	.37	.70	-.90
64	fluorine	.84	-.34	.09	.36	2.06	-1.46
15	accordion	.83	-.34	.09	.35	.24	-.34
107	secede	.83	-.31	.09	.28	.56	.48
102	khaki	.83	-.26	.09	.39	1.27	-.77
70	prosaic	.83	-.20	.09	.38	2.62	-1.78
16	apologize	.84	-.19	.09	.38	.86	-1.40
35	jostle	.83	-.19	.09	.40	.58	-1.12
9	drowsy	.81	-.14	.09	.38	.05	-1.08
44	separate	.79	-.06	.08	.36	.92	.17
68	ascetic	.80	-.03	.08	.36	1.96	-.62
124	reticulate	.80	-.02	.08	.38	2.06	-1.68
84	evanescent	.81	.02	.08	.41	1.63	-1.37

Note. N = 1,037.

[a]Standard error for the logit difficulty value in the preceding column.

Table continues

Table 4 (cont'd)

	Item	*p*	Logit difficulty	Std error[a]	Item-total corr	Between fit	Total fit
88	torrid	.78	.03	.08	.20	4.51	1.92
12	religious	.79	.13	.08	.38	1.21	.43
90	prophylactic	.78	.15	.08	.42	2.45	-1.55
54	luscious	.77	.20	.08	.42	.94	-1.67
57	excerpts	.78	.26	.08	.31	.35	.94
104	pennant	.74	.37	.08	.26	1.57	2.28
60	chauffeur	.75	.37	.08	.38	-.36	-.16
23	lenient	.73	.41	.08	.43	2.67	-.21
52	persevere	.70	.66	.07	.27	3.48	.31
110	silhouette	.68	.70	.07	.43	1.41	-1.62
32	spate	.70	.77	.07	.40	.84	-1.12
50	persistent	.65	.88	.07	.38	-.28	-.03
95	chrysanthemum	.66	.89	.07	.31	1.68	3.07
62	interpreter	.65	.91	.07	.39	1.35	.61
42	prevalent	.65	.91	.07	.36	1.08	1.71
69	hieratic	.64	1.00	.07	.30	4.26	4.19
51	conscientious	.60	1.15	.07	.35	.71	.89
105	diaphragm	.60	1.18	.07	.39	-.62	-.57
7	vacuum	.61	1.18	.07	.37	-.13	1.33
34	facile	.61	1.23	.07	.31	2.21	3.32
111	apocryphal	.57	1.36	.07	.38	-1.29	.68
101	ascension	.57	1.37	.07	.46	1.77	-2.54
78	vagary	.55	1.46	.07	.28	4.93	4.04
74	sycophants	.54	1.52	.07	.34	2.31	3.25
100	aerie	.52	1.59	.07	.31	4.88	4.30
116	exacerbate	.50	1.68	.07	.28	2.76	3.62
98	cirrhosis	.49	1.76	.07	.40	-.99	-.65
73	acquiesce	.48	1.81	.07	.35	1.44	1.58
96	deciduous	.46	1.84	.07	.26	4.24	4.35
93	malleable	.46	1.89	.07	.35	.46	1.76
115	acrimonious	.45	1.94	.07	.39	2.84	.23
81	sangfroid	.44	2.19	.07	.38	4.15	-.15
119	halcyon	.41	2.23	.07	.27	4.36	3.74
80	calumny	.41	2.24	.07	.42	1.37	-1.23
122	comity	.37	2.30	.07	.35	1.67	1.61
43	preceded	.36	2.33	.07	.26	3.61	4.11
109	occurrence	.32	2.52	.07	.24	3.76	4.18
85	recherche	.32	2.75	.08	.39	2.79	-1.06
106	diphtheria	.26	2.87	.08	.24	5.28	3.49
121	ukase	.23	3.27	.09	.30	2.89	.54
82	raillery	.24	3.29	.09	.34	2.24	-.26
75	rapprochement	.20	3.51	.09	.22	6.58	.65
Deleted items:							
21	chalk	.96	-2.29	.18	-.01	4.05	.46
29	quarrel	.91	-1.52	.12	.39	5.20	-1.48
41	subversive	.93	-1.08	.11	.40	4.13	-1.61

Note. N = 1,037.

[a]Standard error for the logit difficulty value in the preceding column.

Table continues

Table 4 (cont'd)

	Item	*p*	Logit difficulty	Std error[a]	Item-total corr	Between fit	Total fit
89	virile	.93	-1.06	.11	.36	2.94	-1.50
87	audacity	.85	-.83	.09	.43	5.28	-1.94
86	trite	.86	-.49	.09	.41	2.64	-1.58
112	toupee	.79	-.29	.08	.46	5.78	-3.55
113	zeppelin	.77	-.13	.07	.08	4.08	3.35
24	wane	.78	-.12	.08	.55	7.62	-5.77
77	ennui	.82	-.02	.08	.43	3.08	-1.84
114	larynx	.67	.27	.07	.18	4.01	3.58
59	athlete	.72	.38	.08	.17	4.15	3.62
11	saxophone	.64	.51	.07	.22	3.76	4.33
8	pronunciation	.62	.52	.07	.20	4.35	4.24
14	weird	.63	.56	.07	.22	3.54	3.74
97	collander	.60	.58	.07	.07	7.44	6.25
63	accommodate	.57	.80	.07	.16	5.64	6.43
99	cacophony	.57	.88	.07	.11	7.39	8.22
71	asperity	.56	1.02	.07	.13	6.38	6.47
117	colloquy	.49	1.28	.07	.48	4.74	-6.07
83	maelstrom	.43	1.59	.07	.47	5.03	-5.22
120	nacreous	.45	1.80	.07	.19	4.40	5.27
47	mischievous	.37	1.86	.07	.17	6.81	3.99
125	internecine	.45	1.90	.07	.25	3.94	4.58
10	embarrassment	.32	2.01	.07	.08	7.54	6.03
55	legerdemain	.35	2.04	.07	.16	7.46	3.23
123	condign	.31	2.12	.07	.17	4.89	2.80
108	irresistible	.33	2.39	.07	.21	5.29	5.00
103	caricature	.24	2.50	.08	-.17	13.6	8.33
91	supersede	.12	3.37	.10	.13	5.01	1.18
94	inoculate	.11	3.41	.10	-.08	9.79	2.34
118	lachrymose	.07	4.01	.13	-.29	16.26	2.00
76	hebetude	.07	4.18	.13	-.18	13.49	1.33
79	desiccate	.05	4.32	.14	-.03	9.25	.74
92	rarefy	.04	5.39	.18	-.00	7.09	.69

Note. N = 1,037.

[a]Standard error for the logit difficulty value in the preceding column.

because they fit the Rasch model and did not seriously detract from overall scale reliability.

The standard errors (for the logit difficulty values) were low for all items that had difficulties less than $p = .9$ (a logit difficulty value of -1.0). Such low standard errors can be expected when the sample is as large as the one used in this study.

Fit values for the final item set tended to be negative, indicating overfit to the Rasch model. Further iteration to remove those items that misfit (high positive fit values) for the final item set would have resulted in little or no gain in terms of internal consistency.

Item difficulties ranged from .20 to 1.00, from quite difficult to very easy. The distribution of item difficulties contained an overrepresentation of easier items; the median item difficulty was $p = .76$ (or logit difficulty approximately equal to .30). The most difficult items were deleted--respondents may have guessed on these items, which resulted in low or negative item-total correlations and misfit to the Rasch model. It may be desirable to experiment further with difficult spelling items by changing the test format to require supplied rather than selected spellings.

A principal components analysis was performed on the 90 items comprising the final version of the spelling test. One dominant factor was found (eigenvalue = 11.96), although 30 factors with eigenvalues greater than one were identified. This suggests that the Spelling test is assessing primarily one attribute. No words (items) had negative loadings on the first factor, although 20 words loaded less than .30, including 3 less than .20. The three words with the lowest loadings on the first factor were *because* (loading .01), *system* (loading .10), and *faction* (loading .19). All three are very easy items, a fact that can influence the structure obtained from a principal components analysis.

Spelling vocabulary test. Analysis of this measure entailed calculation of internal-consistency reliability and item fit with and then without items that were deleted from the spelling test. Internal-consistency reliability with all 50 vocabulary items was .85. Item difficulties, item-total correlations, and values for fit statistics for all 50 items are presented in Table 5. The analysis was then repeated with the removal of items corresponding to items that had been deleted from the English spelling test; 34 items remained. Although some of these 34 items detracted a little from the consistency and unidimensionality of this measure, all were kept to provide consistency with the items on the spelling test. The internal-consistency reliability of this 34-item set was .80. The logit difficulty values for this reduced set are also presented in Table 5 in the column labeled "Logit diff2." (The item

Table 5

Difficulty Indices, Item-Total Correlations, and Fit Statistics for Spelling Vocabulary Items

Item	*p*	Logit diff1[a]	Std error[b]	Logit diff2[c]	Item-total corr	Between fit	Total fit
23 bizarre	.98	-4.54	.27	-4.26	.08	1.40	.13
26 barricade	.98	-4.18	.23	-3.70	.21	.81	.01
25 serene	.94	-3.26	.15	-2.86	.33	3.82	-.80
27 scour	.93	-2.96	.13	-2.57	.23	-.28	-.14
1 lenient	.92	-2.83	.13	-2.48	.32	2.57	-.91
24 meager	.90	-2.58	.11	-2.23	.42	5.80	-1.83
48 audacity	.84	-1.86	.09	--	(.33)	1.92	-1.27
16 askew	.78	-1.32	.08	-1.05	.44	5.70	-3.41
15 faction	.77	-1.32	.08	-1.02	.50	7.23	-4.83
47 prevalent	.78	-1.30	.08	-.99	.45	6.61	-4.03
3 encumber	.75	-1.12	.08	-.83	.47	6.32	-4.44
22 jostle	.69	-.78	.07	-.50	.39	2.96	-2.13
2 wane	.68	-.71	.07	--	(.50)	5.93	-6.01
6 avert	.67	-.69	.07	-.41	.45	4.14	-3.77
11 pious	.67	-.63	.07	-.34	.48	5.31	-5.85
45 trite	.65	-.59	.07	--	(.33)	2.85	-.92
5 exacerbate	.64	-.48	.07	-.20	.44	5.01	-4.59
19 facile	.64	-.47	.07	-.19	.35	1.94	-1.17
17 acquiesce	.59	-.26	.07	.03	.51	6.18	-6.89
4 acrimonious	.58	-.20	.07	.08	.44	4.21	-4.84
49 torrid	.53	.05	.07	.33	.40	2.44	-3.85
46 subversive	.51	.05	.07	--	(.44)	3.78	-4.29
39 comity	.49	.20	.07	.47	.21	2.38	3.83
50 virile	.46	.35	.07	--	(.37)	4.03	-1.80
35 raillery	.44	.36	.07	.65	.26	3.83	3.36
28 ennui	.45	.50	.07	--	(.32)	5.20	.07
31 calumny	.43	.51	.07	.78	.12	6.72	6.11
32 pithy	.38	.64	.07	.92	.33	.99	-.55
34 halcyon	.38	.69	.07	.98	.24	3.39	2.28
20 rapprochement	.38	.72	.07	.98	.05	9.29	8.10
33 sangfroid	.38	.79	.07	1.06	.13	6.45	4.41
21 hebetude	.35	.85	.07	--	(.24)	1.03	1.81
18 sycophants	.35	.89	.07	1.16	.42	3.87	-4.13
38 ukase	.33	.96	.07	1.26	.30	-.20	.12
29 vagary	.31	.96	.07	1.24	.16	6.50	3.37
37 nacreous	.32	.97	.07	--	(.16)	4.58	3.86
7 ascetic	.34	1.00	.07	1.27	.32	3.12	-2.02
30 desiccate	.32	1.00	.07	--	(.26)	3.54	1.63
41 condign	.31	1.02	.07	--	(.10)	6.66	5.76
12 lachrymose	.32	1.07	.07	--	(.42)	4.24	-3.03
36 maelstrom	.31	1.09	.07	--	(.25)	2.31	2.02
14 asperity	.26	1.49	.08	--	(.35)	3.18	-.95
42 recherche	.22	1.53	.08	1.80	-.11	12.08	6.89
13 spate	.20	1.80	.09	--	(.35)	2.50	-1.44
8 hieratic	.18	1.85	.09	2.13	.06	5.77	2.87
44 internecine	.17	1.90	.09	--	(.09)	6.04	2.17
40 evanescent	.17	1.96	.09	2.18	-.00	8.44	2.94
9 prosaic	.17	2.06	.09	2.32	.24	5.04	-1.36
43 reticulate	.13	2.30	.10	2.54	.17	3.11	.50
10 colloquy	.12	2.52	.11	--	(.19)	3.54	-.15

Note. $N = 1{,}054$.

[a]Logit difficulty value when all spelling vocabulary items were included in the analysis.

[b]Standard error for the logit difficulty value in the preceding column.

[c]Logit difficulty value when only the 34 spelling vocabulary items that corresponded to spelling items were included in the analysis.

difficulties for the full 50-item set are in the column headed "Logit diff1.") Also, the item-total correlations for the deleted items were taken from the initial analysis and for the retained items from the analysis of the 34-item subset. A total spelling vocabulary score was computed using dichotomous scoring for the 34-item set.

Word familiarity. The purpose of this measure was to provide a sense of how familiar examinees were with the various words they spelled and defined. This measure was strictly for experimental purposes, with no intention that it be used beyond this study. Reliability was calculated for interest rather than to demonstrate adequacy of the instrument as a scale. The internal-consistency reliability for the 50 items on the word familiarity measure was .95. The internal-consistency reliability with the deletion of the 16 items corresponding to the items that had been deleted from the English spelling test was .92. Item means and standard deviations are presented in Table 6 for word familiarity. A total word familiarity score was computed, using responses to the 34-item set to provide some consistency with the spelling test.

Difficulty Order of Items by Subgroup

Good test items do not interact with examinee characteristics other than the trait or attribute being measured. For example, good spelling test items assess only spelling ability, not a combination of spelling ability, guessing, and other factors. This means that the ordering of difficulty of the items should not vary for subgroups differing in sex, age, vocabulary knowledge, and so on. While the actual item difficulties may vary across subgroups, the items should maintain the same order of difficulty. That is, *serene* should be easier to spell than *raillery* for both men and women, for good spellers as well as poorer spellers.

To examine the stability of the difficulty order of the items on the spelling test, logit difficulties were calculated separately for males and females, by vocabulary knowledge (three groups), by age (three groups), and by spelling ability (three groups). Logit difficulties were then correlated across groups. Items were identified that were one logit or more different in difficulty between groups and displaced in rank order by two or more positions. One logit is very roughly equivalent to one standard deviation, in this case one standard deviation of item difficulty. Four items were identified as behaving the most inconsistently across groups, and it was decided that these items should be deleted from the test. Table 7 presents the correlations among item difficulties for various subgroups, and Table 8 presents the rank order and logit difficulties for items that were identified as behaving differently for the different subgroups. Items that were deleted because of inconsistency in rank ordering are listed as well.

Table 6

Means and Standard Deviations for Word Familiarity Ratings

Word	Mean	*SD*	Word	Mean	*SD*
barricade	4.94	.34	acrimonious	2.80	1.24
bizarre	4.92	.35	prosaic	2.73	1.31
meager	4.75	.66	ennui	2.70	1.57
serene	4.75	.70	rapprochement	2.69	1.20
lenient	4.73	.80	reticulate	2.63	1.13
scour	4.70	.77	maelstrom	2.54	1.31
prevalent	4.62	.81	colloquy	2.47	1.16
avert	4.61	1.05	vagary	2.42	1.23
audacity	4.50	1.00	hieratic	2.38	1.24
subversive	4.21	1.09	sycophants	2.25	1.38
faction	4.14	1.18	asperity	2.23	1.08
jostle	4.10	1.16	spate	2.19	1.28
trite	4.09	1.22	evanescent	2.08	1.18
torrid	4.04	1.15	halcyon	2.02	1.29
askew	4.02	1.25	calumny	1.96	1.13
encumber	3.98	1.15	lachrymose	1.83	1.17
virile	3.91	1.38	sangfroid	1.78	1.16
pious	3.87	1.34	raillery	1.73	1.04
wane	3.68	1.36	internecine	1.70	.97
facile	3.43	1.35	comity	1.65	.96
acquiesce	3.41	1.48	nacreous	1.51	.80
ascetic	3.31	1.31	recherche	1.49	.89
exacerbate	3.00	1.43	condign	1.49	.75
pithy	2.97	1.31	hebetude	1.30	.60
desiccate	2.92	1.39	ukase	1.20	.59

Note. *N*s ranged from 1,505 to 1,511. The rating scale for each word ranged from 1 for totally unfamiliar to 5 for very familiar.

Table 7

Correlations Between Item Difficulty Values for Various Examinee Groups

Group	Females	Age2	Age3	Voc2	Voc3	Sp2	Sp3
Males	.98						
Age1 (low-age)		.98	.96				
Age2 (medium-age)			.98				
Vocab1 (low-ability)				.97	.94		
Vocab2 (medium-ability)					.97		
Spell1 (low-ability)						.97	.92
Spell2 (medium-ability)							.96
n	472	315	314	334	329	354	347

Note. Total *N* = 1,037; number of males = 519 (information on sex was missing for 46 examinees); *n*(age1) = 361; *n*(vocab1) = 324; *n*(spell1) = 336.

Table 8

Item Difficulty and Rank Order of Spelling Items by Examinee Group

Item	Males	Females	Item	Males	Females
faction	-2.90 (5)	-1.91 (13)	prejudicial	-2.03 (9)	-3.35 (5)
decided	-2.32 (7)	-3.35 (5)			

Item	Age1	Age2	Age3	Voc1	Voc2	Voc3	Sp1	Sp2	Sp3
usage	-2.15 (8.5)	-2.91 (4)	-3.86 (1.5)						
barricade	-1.39 (15)	-1.43 (20)	-2.46 (9)				-1.14 (17)	-2.10 (12)	-3.14 (3)
encumber	-.27 (43)	-.59 (35)	-1.52 (21)						
facile	.69 (61)	1.36 (72)	1.81 (75)						
rapproche-ment	2.96 (92)	3.47 (94)	4.05 (94)				2.52 (92)	3.84 (94)	3.74 (94)
avert				-1.47 (13)	-3.00 (7)	-1.72 (15)	-1.43 (13)	-2.69 (6)	-2.05 (13)
subtle				-1.00 (21)	-3.00 (7)	-2.13 (10)	-1.06 (19)	-2.69 (6)	--[a]
preceded				1.75 (80)	2.39 (85)	2.92 (89)			
occurrence				1.96 (86)	2.40 (86)	3.14 (90)			
principle							-1.34 (14)	-2.51 (8)	--[a]
leopard							-1.10 (18)	-2.35 (9)	-2.45 (9)

Note. Values in parentheses are item rank orders, with lower values indicating easier items.

[a]These items could not be calibrated for these groups because all members answered the items correctly.

Table continues

Table 8 (cont'd)

Item	Age1	Age2	Age3	Voc1	Voc2	Voc3	Sp1	Sp2	Sp3
flannel							-.87 (23)	-1.08 (22)	-2.45 (9)
serene							-.68 (28)	-1.81 (17)	-1.76 (16)
bizarre							-.63 (30)	-.92 (25)	-1.54 (18)
calendar							-.62 (31)	-.58 (33)	-1.76 (16)
jewelry							-.18 (42)	-.84 (26)	-1.20 (23)
prophylactic							.39 (60)	.04 (48)	-.41 (41)
Deleted items:									
subversive	-.66 (28)	-1.49 (19)	-2.46 (9)	-.70 (28)	-1.64 (17)	-2.13 (10)	-.65 (29)	-1.79 (14)	--[a]
virile	-.56 (32)	-1.68 (16)	-3.16 (3)	-.61 (31)	-1.88 (15)	--[a]	-.75 (25)	-1.58 (18)	-2.45 (9)
trite	-.23 (44)	-.56 (36)	-1.42 (22)	.00 (49)	-1.08 (24)	-1.91 (13)	-.21 (41)	-.74 (29)	-1.76 (16)
ennui							.14 (52)	.10 (50)	-1.54 (18)

Note. Values in parentheses are item rank orders, with lower values indicating easier items.

[a]These items could not be calibrated for these groups because all persons in the groups answered the items correctly.

The order of items by difficulty was highly similar across all groups. The greatest difference in item ordering was for groups classified as poor and good spellers. Items differing in order and logit difficulty tended to be the easiest and hardest items. For these items, a relatively small number of persons' responses would materially affect the item order and difficulty values. In summary, the items' difficulty orders were generally quite stable across subgroups.

Distribution of Spelling Scores

Spelling scores in this sample ranged from 21 to 90 correct out of 90 scored items (23 to 100%), with a mean of 64.9 (72%). The floor (easy items) seemed adequate but the ceiling (difficult items) could be raised: one person achieved a perfect score and 7% got more than 90% of the items correct. The distribution of spelling scores was slightly negatively skewed (skewness = -.47) and mesokurtic (neither flat nor too peaked--kurtosis = -.01)--so the distribution of spelling scores was essentially normal. The slight negative skewness might be alleviated by including several more highly difficult items on the test. Figure 1 presents a display of the distribution of spelling scores with a superimposed normal curve. Figures 2 and 3 present the distribution of spelling scores for females and males, respectively. The mean, skewness, and kurtosis for females were 67.83, -.45, and .02; for males, 62.72, -.37, and -.16. The dispersion of spelling scores was not as great for females than for males (the standard deviations were, respectively, 10.94 and 12.65). (Statistical analyses of sex differences will be presented in a later section.)

Relationships Among Experimental Measures

The relationships among the experimental measures were examined in three ways. First, examinees' scores on the measures were correlated with each other. Second, item indices were correlated. Item indices were logit difficulty value for the spelling ability and spelling vocabulary tests and the rating mean for the words on the word familiarity measure. Third, patterns of correct spelling and vocabulary were related to familiarity score for individual words. Samples of item patterns are provided.

Table 9 presents the correlations among the various person measures. Spelling ability, spelling vocabulary, and word familiarity were strongly correlated. Spelling ability was significantly but weakly correlated with the perceived importance of spelling (.22) and more-strongly correlated with self-rated spelling ability (.50). The perceived importance of spelling was strongly related to the perceived importance of grammar (.74), and self-rated spelling ability was moderately related to self-rated grammar ability (.55). The relationships among the

Figure 1
Overall Distribution of Spelling Scores

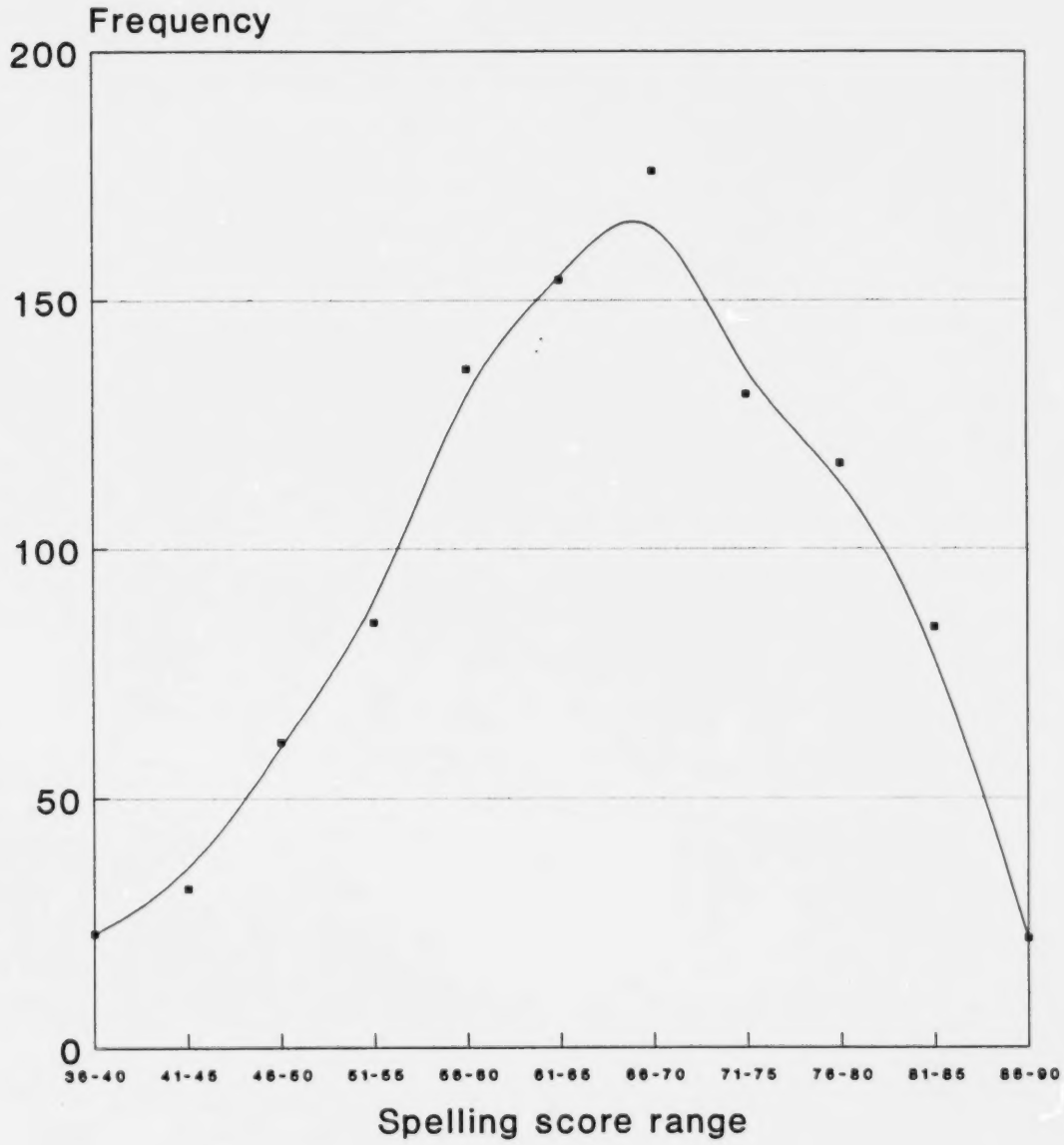


Figure 2
Distribution of Spelling Scores, Males

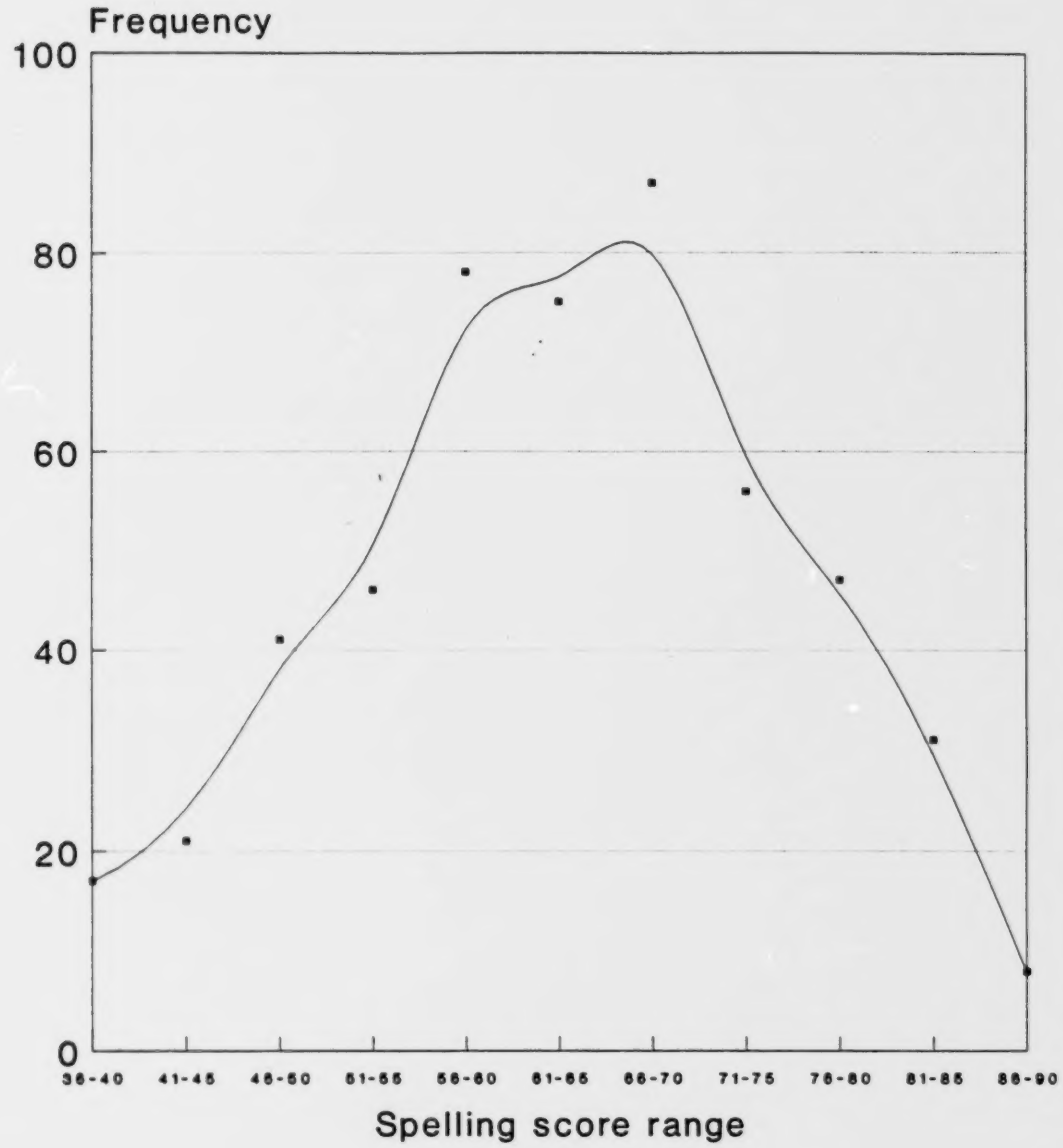


Figure 3
Distribution of Spelling Scores, Females

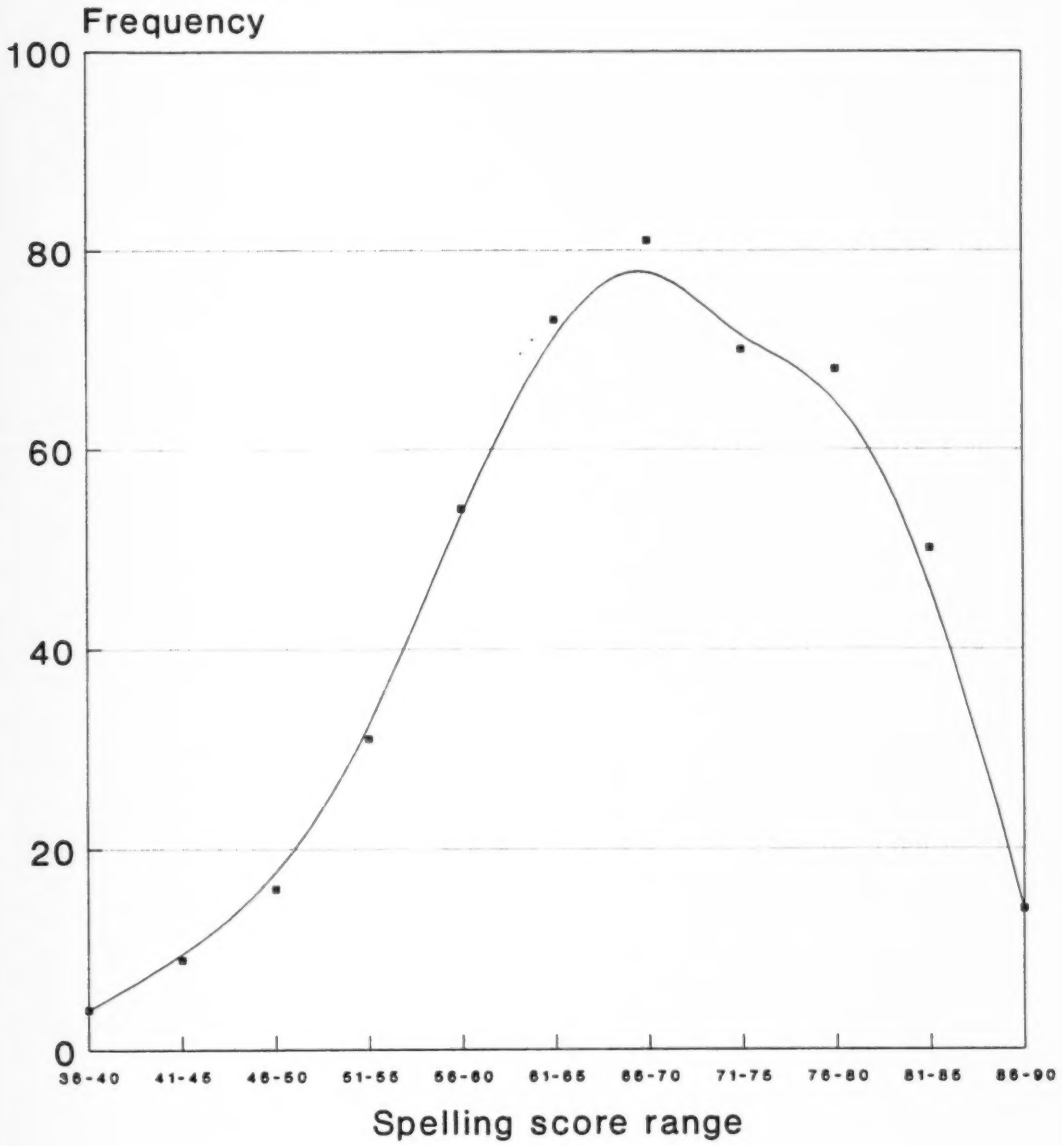


Table 9

Relationships Among Experimental Measures

Measure	Spelling ability	Spelling vocab	Word fam	Rated spelling importance	Rated spelling ability
Spelling vocabulary	.71	--	.76	.08	.21
Word familiarity	.61	.76	--	.10	.22
Rated importance of:					
Reading quickly	.12	.19	.20	.29	NS
Reading accurately	NS	.11	.13	.37	.08
Writing reports, letters	.11	.12	.13	.34	.11
Correct spelling	.22	.08	.10	--	.41
Correct grammar	.20	.13	.18	.74	.28
Attention to detail	.08	.08	.11	.39	.17
Rated ability at:					
Reading quickly	.16	.19	.21	.12	.21
Reading accurately	.15	.24	.23	.08	.15
Writing reports, letters	.23	.19	.28	.15	.30
Correct spelling	.50	.21	.22	.41	--
Correct grammar	.40	.29	.30	.27	.55
Attention to detail	.14	.12	.14	.12	.21

Note. *Ns* = 975-1,038. Only correlations significant at $p < .01$ are listed; correlations that are not significant are indicated by "NS."

experimental tests were similar for males and females with two exceptions. Significant correlations were found for females between spelling score and self-rated ability to read quickly (.27) and self-rated ability to read accurately (.23). These relationships were not significant for men.

Table 10 presents correlations among the item indices. The strongest relationship was found between the item difficulties for the spelling vocabulary test and the word familiarity means. That is, as words were more familiar, on average they were also easier to spell. The relationship between spelling difficulty and word familiarity was also strong and negative. As words were more familiar, they were easier to spell, on average. The correlation between spelling difficulty and vocabulary difficulty was moderate.

The correlations for both person and item measures between spelling and word familiarity indicate that word familiarity is an important concomitant of spelling accuracy. For 45 of the 50 words on the word familiarity measure, the word familiarity means were significantly higher for those persons who could spell the word than for those who could not. In four cases, the difference in word familiarity means between those selecting the correct versus incorrect spelling was not significant. In only one case was the difference significant in the direction of those spelling the word correctly being less familiar with it (for the word *lachrymose*).

At the level of individual words, is knowledge of word meanings (vocabulary) important in spelling? Correct versus incorrect word (vocabulary) knowledge and spelling were cross-tabulated for all 50 words on the spelling vocabulary test. Significant relationships, as indicated by significant chi-square values ($p < .01$), were found between spelling and word knowledge for all words except the following 11: *hieratic* (most people could spell it but not define it), *prosaic* (spell but not define), *rapprochement* (many could define but not spell it), *hebetude* (many could define but not spell it), *desiccate* (define but not spell), *nacreous* (no relationship between defining and spelling), *comity* (no relationship), *evanescent* (spell but not define), *condign* (no relationship), *recherche* (not define and not spell), and *reticulate* (spell but not define). The relationship between vocabulary knowledge and spelling seems to hold more strongly for less-difficult words (in terms of both spelling and vocabulary) and tends to break down for the more-difficult words. In general, greater word knowledge and greater spelling knowledge tend to go together.

Is word familiarity important in vocabulary knowledge? Mean word familiarity scores were compared for those who selected the correct word meaning versus those who did not, for the words on the spelling vocabulary test. For 42 words, the mean word

Table 10

Relationships Among Item Indices

Item index	Vocab diff	WF mean[a]
Spelling difficulty	.56 (34)	-.76 (34)
Vocabulary difficulty	--	-.82 (33)

Note. The values in parentheses indicate the number of items for each correlation.

[a]The mean familiarity rating for each word.

familiarity scores were significantly higher for those who could identify the correct word meanings than for those who could not. For seven words, the differences were nonsignificant. For the remaining word, *recherche*, the difference was in the opposite direction.

Table 11 presents patterns of word familiarity, spelling accuracy, and vocabulary knowledge for two easy, two moderate, and two difficult words and four words with unusual patterns. For each word, Table 11 presents the chi-square value for the relationship between spelling and vocabulary score. Unless noted, all chi-square values are significant at the .01 level. The numbers in the 2 x 2 subtables are the raw frequencies of those who correctly and incorrectly spelled the word and selected the correct and incorrect word meanings. The numbers in the 2 x 2 subtable margins are the mean (and standard deviation in parentheses) word familiarity scores for those who correctly and incorrectly spelled the word and selected the correct and incorrect word meanings. Logit spelling difficulty is found in the subtable heading.

Relationships of Experimental Measures With the Standard Foundation Battery

Table 12 presents the correlations of the experimental measures with the tests in the standard Foundation battery. The strongest correlations were found between spelling ability and English Vocabulary (.82) and Reading Efficiency (.58). Not surprisingly, the same two tests were also the most strongly correlated with spelling vocabulary (1.00 and .67, respectively) and word familiarity (.78 and .53). This was true for both males and females. A moderate significant correlation was also found between spelling ability and Number Checking (.40). Several significant relationships were found for males but not females. These correlations ranged from .12 to .21 and thus represent relationships of low magnitude. Significant correlations for men but not women were found between spelling and Structural Visualization (.20) and Paper Folding (.21) and between spelling vocabulary and Number Checking (.19), Structural Visualization (.20), Wiggly Block (.12), Paper Folding (.19), and Number Memory (.17).

Two correlations were significant for women and not men. These were correlations between spelling and father's years of education (-.16) and mother's education (-.15). These correlations may be misleading because of a confound between the age of examinees at the Foundation and the years of education of examinees' parents. In this sample, age of examinee correlates -.34 with father's years of education and -.36 with mother's years of education. In other words, children of highly educated parents tend to come in for testing at relatively early ages, while children of less-educated parents are more likely to come

Table 11

Joint Patterns for Spelling Accuracy, Vocabulary Knowledge, and Word Familiarity for Selected Words

Easy words

Word: *faction* — Spelling difficulty (logits): -2.43

Joint frequency table

		Vocabulary NC	Vocabulary C
Spelling	NC	18	8
	C	220	764

Word familiarity means

	Spelling NC	Spelling C	Vocabulary NC	Vocabulary C
	2.52	4.18	2.96	4.49

Chi-square value = 28.4 — Overall word familiarity *SD* = 1.07

Word: *avert* — Spelling difficulty (logits): -1.73

Joint frequency table

		Vocabulary NC	Vocabulary C
Spelling	NC	32	19
	C	310	646

Word familiarity means

	Spelling NC	Spelling C	Vocabulary NC	Vocabulary C
	3.30	4.25	3.62	4.52

Chi-square value = 18.5 — Overall word familiarity *SD* = 1.00

Moderate words

Word: *ascetic* — Spelling difficulty (logits): -0.03

Joint frequency table

		Vocabulary NC	Vocabulary C
Spelling	NC	168	35
	C	522	279

Word familiarity means

	Spelling NC	Spelling C	Vocabulary NC	Vocabulary C
	2.88	3.44	3.25	3.49

Chi-square value = 22.5 — Overall word familiarity *SD* = 1.31

Note. "NC" and "C" represent "Not correct" and "Correct," respectively.

Table continues

Table 11 (cont'd)

Word: *torrid* — Spelling difficulty (logits): 0.03

Joint frequency table

		Vocabulary	
		NC	C
Spelling	NC	125	92
	C	378	416

Word familiarity means

Spelling		Vocabulary	
NC	C	NC	C
3.55	4.19	3.63	4.46

Chi-square value = 6.4

Overall word familiarity *SD* = 1.06

Difficult words

Word: *ukase* — Spelling difficulty (logits): 3.27

Joint frequency table

		Vocabulary	
		NC	C
Spelling	NC	563	215
	C	113	90

Word familiarity means

Spelling		Vocabulary	
NC	C	NC	C
1.12	1.52	1.13	1.35

Chi-square value = 20.2

Overall word familiarity *SD* = 0.63

Word: *raillery* — Spelling difficulty (logits): 3.29

Joint frequency table

		Vocabulary	
		NC	C
Spelling	NC	467	327
	C	97	105

Word familiarity means

Spelling		Vocabulary	
NC	C	NC	C
1.58	2.33	1.57	1.94

Chi-square value = 7.2

Overall word familiarity *SD* = 1.04

Note. "NC" and "C" represent "Not correct" and "Correct," respectively.

Table continues

Table 11 (cont'd)

Words with unusual patterns

Word: *hebetude* — **Spelling difficulty (logits):** 4.18

Joint frequency table

		Vocabulary NC	Vocabulary C
Spelling	NC	601	326
	C	46	14

Word familiarity means

Spelling NC	Spelling C	Vocabulary NC	Vocabulary C
1.30	1.24	1.31	1.28

Chi-square value = 3.0 (p>.05)

Overall word familiarity *SD* = 0.60

Word: *condign* — **Spelling difficulty (logits):** 2.12

Joint frequency table

		Vocabulary NC	Vocabulary C
Spelling	NC	466	222
	C	211	86

Word familiarity means

Spelling NC	Spelling C	Vocabulary NC	Vocabulary C
1.46	1.58	1.46	1.57

Chi-square value = 0.9 (p>.05)

Overall word familiarity *SD* = 0.76

Word: *recherche* — **Spelling difficulty (logits):** 2.75

Joint frequency table

		Vocabulary NC	Vocabulary C
Spelling	NC	535	171
	C	228	53

Word familiarity means

Spelling NC	Spelling C	Vocabulary NC	Vocabulary C
1.27	2.02	1.53	1.33

Chi-square value = 3.0 (p>.05)

Overall word familiarity *SD* = 0.83

Note. "NC" and "C" represent "Not correct" and "Correct," respectively.

Table continues

Table 11 (cont'd)

Word: *comity* — Spelling difficulty (logits): 2.30

Joint frequency table

		Vocabulary	
		NC	C
Spelling	NC	344	288
	C	172	185

Chi-square value = 3.3 (p>.05)

Word familiarity means

	Spelling		Vocabulary	
	NC	C	NC	C
	1.36	1.56	1.59	1.74

Overall word familiarity *SD* = 0.96

Note. "NC" and "C" represent "Not correct" and "Correct," respectively.

Table 12

Correlations Between Experimental Tests and Tests in the Standard Foundation Battery

Test	Spelling ability	Spelling vocabulary	Word familiarity	*Ns*
Number Checking	40 (36)	15 (12)	12 (11)	932-970
Color Perception	-	-	-	949-987
Ideaphoria	35 (33)	37 (32)	31 (30)	928-966
Foresight	20 (19)	24 (21)	21 (19)	928-965
Inductive Reasoning	-	-	-	948-986
Analytical Reasoning	34 (27)	37 (27)	19 (17)	936-973
Number Series	42 (38)	34 (28)	23 (21)	923-958
Structural Visualization	10 (09)	16 (13)	-	909-946
Wiggly Block	-	-	-	934-956
Paper Folding	12 (11)	16 (13)	-	933-971
Personality	-	-	-	945-982
Tonal Memory	29 (27)	26 (22)	21 (20)	943-981
Pitch Discrimination	20 (17)	22 (17)	15 (13)	941-979
Rhythm Memory	20 (17)	17 (14)	-	943-981
Memory for Design	-	-	-	922-958
Silograms	40 (36)	32 (27)	22 (20)	937-974
Number Memory	25 (23)	16 (13)	09 (08)	936-973
Observation	-	-	-	934-972
Finger Dexterity	12 (10)	-	-	938-976
Tweezer Dexterity	-	-	-	935-973
English Vocabulary	82 (77)	100 (87)	78 (74)	950-988
Mathematics Vocabulary	52 (45)	54 (43)	37 (32)	532-559
Writing Speed	NA (37)	NA (33)	NA (31)	949-987
Reading Efficiency	58 (47)	67 (51)	53 (43)	909-947

Note. Only correlations significant at the .01 level (2-tailed) are shown. Correlations are corrected for attenuation, with uncorrected correlations in parentheses. Leading decimals are omitted. "NA" represents "not available," for disattenuated correlations involving tests for which reliability coefficients were not available.

in during their college or adult years. Because of this confound, the correlations between spelling and parents' years of education probably reflect the positive relationship between age and spelling ability (along with the negative correlation between parents' years of education and age of examinee) rather than a negative influence for parents' education on examinees' spelling ability.

With these exceptions, the pattern of relationships was similar for males and females.

Factor Structure of Spelling With Standard Battery Tests

Principal components analyses were performed of scores on the spelling ability test and the standard Foundation battery of tests. Analyses were performed separately for males and females, as well as for combined cases. Varimax rotation was used to provide the most interpretable solutions. Table 13 presents the results of these analyses. Spelling clearly loaded with English Vocabulary and Reading Efficiency on a factor that may be interpreted as verbal facility. The patterns for males and females were similar except that for males, Number Checking and Foresight loaded on the same factor as spelling, English Vocabulary, and Reading Efficiency. This result is suggestive of a slightly different nature for spelling ability among males than among females, but further work would be needed to investigate this more closely.

The results of this factor (principal components) analysis are similar to those of Coren (1989), who found spelling to load on a factor labeled "crystallized intelligence." Vocabulary and verbal comprehension tests also loaded on that factor.

Prediction of Spelling Ability From the Standard Battery Tests

Table 14 displays the results of multiple regressions of spelling scores on the standard battery tests for males and females. As can be seen, English Vocabulary by itself is an excellent predictor of spelling performance. Number Checking makes a modest increment to the prediction, beyond the prediction of vocabulary alone. When English Vocabulary and Reading Efficiency (the highest correlates of spelling) were removed from the equation, spelling was still predicted fairly well by Number Series, Number Checking, Silograms, Ideaphoria, Memory for Design, Tonal Memory, Inductive Reasoning, Analytical Reasoning, Observation, Wiggly Block, and Paper Folding, with $R = .65$. When regressions without English Vocabulary or Reading Efficiency were run separately for males and females, the prediction was a little poorer for females ($R = .55$) than for males ($R = .65$). Number Series, Number Checking, Ideaphoria, Silograms, Observation, and Memory for Design were significant predictors for both men and women. Pitch Discrimination was an added predictor for women;

Table 13

Factor Structure of Spelling Ability and the Standard Foundation Battery

Test	Factor						
	1	2	3	4	5	6	7
Wiggly Block	80						
Paper Folding	79						
Memory for Design	67						
Analytical Reasoning	64	37					
Number Series	45	35	31	35			
Observation	45			39	33		
English Vocabulary		83					
Spelling		79					
Reading Efficiency		73					
Ideaphoria		57			46		
Tonal Memory			81				
Pitch Discrimination			70				
Rhythm Memory			69				
Silograms				77			
Number Memory				72			
Finger Dexterity					70		
Tweezer Dexterity					61		
Number Checking		38		37	42		
Inductive Reasoning	42				44		31
Personality						85	
Foresight					30	-51	
Color Perception							86

Note. Total N = 1,080. The factors were extracted by means of principal components analysis and rotated to the varimax criterion.

Table 14

Prediction of Spelling Ability From Standard Battery Tests

Test	Full sample		Females		Males	
	R	Incr R^a	*R*	Incr R^a	*R*	Incr R^a
English Vocabulary	769	769	805	805	756	756
Number Checking	803	034	825	020	787	031
Silograms	815	012	832	007	799	012
Inductive Reasoning	820	005	837	005		
Wiggly Block	822	002				
Number Series	826	004	839	002		
Observation					804	005
Number Series					808	004
Wiggly Block					811	003

Note. *Ns* = 415 females and 451 males. All multiple correlation coefficients are significant at the .01 level. Decimals are omitted. Reading Efficiency does not appear in this table because it did not make a significant contribution to prediction beyond the contribution of English Vocabulary.

[a]"Incr *R*" represents the increase in the multiple correlation when the given test was added to the regression.

Inductive Reasoning, Analytical Reasoning, and Finger Dexterity were added predictors for men.

In summary, spelling performance can be predicted well from tests in the standard Foundation battery, especially English Vocabulary.

Sex Differences

Table 15 presents means, standard deviations, and *t* values for sex differences on the experimental measures. As expected, women had higher scores than men on all measures. The differences were, however, statistically significant only for spelling ability and self-ratings involving spelling skill and importance and grammatical skill and importance.

Relationship Between Spelling Ability and Age

The sample was divided into thirds based on age: Group 1 = 14 to 20 years of age, Group 2 = 21 to 30, and Group 3 = 31 and older. A significant main effect for age was found for spelling ability, spelling vocabulary knowledge, and word familiarity, with scores on each measure increasing as age increased. Significant effects were found among both men and women, again with increasing spelling, spelling vocabulary, and word familiarity scores with increasing age. The correlation between spelling and age was higher for females (r = .50) than for males (r = .36). Table 16 presents the mean scores for each age group on these three measures. Perceived importance of spelling and perceived spelling ability did not differ significantly across age groups.

To examine the possible impact of higher-order terms in predicting spelling from age, spelling ability was regressed on age along with age-squared and age-cubed. The R value increased only from .42, for age alone, to .45 for all three terms.

Figure 4 illustrates the relationship between spelling and age for all cases. As can be seen, the shape of the curve is similar to the age curve for English Vocabulary (Statistical Bulletin 1985-36), with spelling ability increasing steadily in the teen years and throughout adulthood. The shape of the curve differs sharply from that of aptitudes, such as Wiggly Block (Statistical Bulletin 1985-27), for which scores level off in the 20s and then begin to decline by age 40. Thus, the age curve for spelling is quite consistent with our expectations for a body of acquired knowledge and not for an aptitude. (See also O'Connor, 1934, pp. 178-192, for a discussion of the aptitude-versus-acquired-knowledge issue.)

Table 15

Sex Differences on Experimental Measures

Measure	Females			Males			t[a]	Effect size[b]
	Mean	*SD*	*n*	Mean	*SD*	*n*		
Spelling ability	67.83	10.94	472	62.72	12.65	519	6.81	.42
Importance of spelling	4.44	.88	441	4.14	.98	490	4.93	.32
Importance of grammar	4.58	.76	441	4.27	.91	490	5.68	.36
Skill at writing letters	3.85	.89	440	3.64	.97	487	3.40	.22
Skill at spelling	3.75	1.09	439	3.46	1.17	486	3.84	.25
Skill at grammar	3.91	.96	440	3.67	.98	488	3.68	.25

[a]All the values listed are significant at the .001 level.

[b]This index is Cohen's (1988) *d*, which is the difference between the two group means divided by the pooled within-group standard deviation.

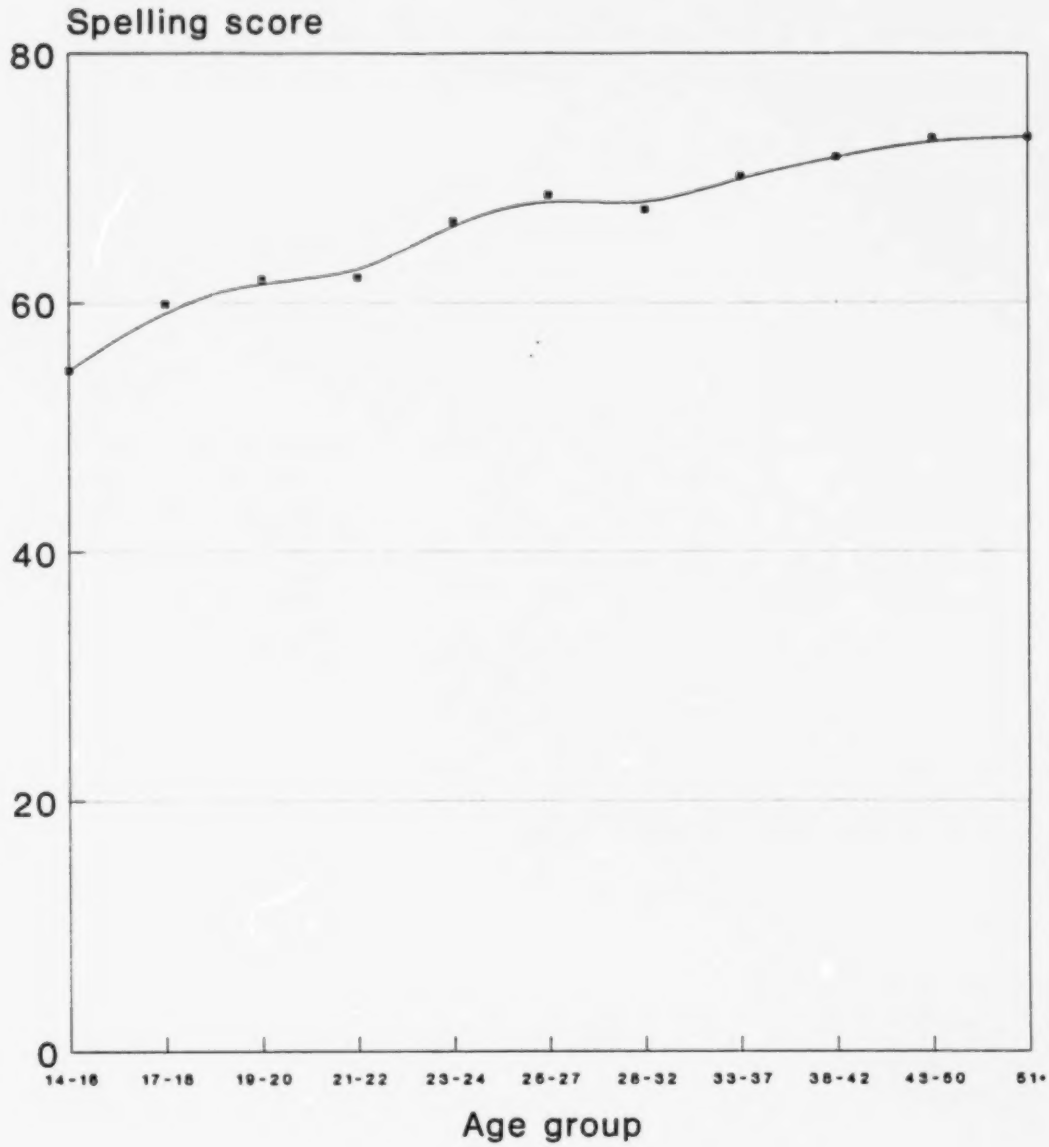
Table 16

Age Differences on Experimental Measures

Measure	Means and *SD*s for age groups[a]			*F*	*p*
	14-20	21-30	30+		
Spelling	59.17 (11.99)	65.41 (11.02)	71.76 (9.63)	110.75	<.001
Spelling vocabulary	15.90 (4.73)	18.48 (4.65)	22.12 (4.50)	148.79	<.001
Word familiarity	101.64 (18.35)	112.97 (18.75)	122.94 (19.09)	104.57	<.001

[a]For each group, the standard deviations are shown in parentheses below the means.

Figure 4
Age Curve for Spelling Ability



Laterality Differences

For the analyses of handedness, examinees were divided into two groups: those who performed at least half the tasks on the handedness test with the left hand (considered to be left-handed) and those who performed all the tasks with the right hand (considered to be right-handed). (The remaining examinees were not included in these analyses.) There were no significant differences related to handedness on any of the experimental measures. There were also no significant differences in the experimental measures based on parental handedness (either mother's or father's). These results held for both males and females.

The potential interaction of parental and examinee handedness was also examined. No significant effects were found for the interaction of parental and examinee handedness at the .01 level. (There were interactive effects of parental and examinee handedness on English Vocabulary, with $p = .03$. Lower scores were found for left-handed children of right-handed mothers or fathers than for right-handed children of right-handed parents.)

Differences related to left versus right eyedness were also examined. As with handedness, examinees who used their left eye for at least half the trials on the eyedness were classified as left-eyed, examinees who used their right eye on all the trials were classified as right-eyed, and the remaining examinees were not included in the analyses. For the overall group, there were no significant differences in the experimental measures between left-eyed and right-eyed examinees. There was, however, one significant difference associated with eyedness for females. Females with left eye dominance scored significantly lower in spelling ability than females with right eye dominance (means of 65.95 versus 68.87, $t = 2.67$, $p < .01$). Thus, there was some evidence of relationships between left-sidedness and spelling ability and vocabulary, but the effects were small and inconsistent.

Differences With College Majors

College majors were categorized into 12 areas: art, biological sciences, business, communication, education, English, engineering, health sciences, history, psychology, social sciences, and undecided. There were significant differences among groups in spelling ability ($F = 3.04$, $p < .01$), spelling vocabulary ($F = 3.86$, $p < .01$), and word familiarity ($F = 4.21$, $p < .01$). Significant pairwise differences ($p < .05$) in mean spelling ability were found between English (Mean = 74.37) and business majors (Mean = 67.46). Differences in mean spelling vocabulary were found between history (24.95) and, respectively, psychology (19.84), business (19.38), and communication (18.82) majors. Mean word familiarity differed significantly between

history (133.10) and business (113.25), education (116.81), and psychology (115.81) majors, and between English (127.18) and social science (122.40) majors and business (113.25) majors. In this sample, the history and English majors tended to have higher scores on all the experimental measures than the other majors, particularly business majors and those who were undecided about their major field.

Education

The correlation between spelling ability and years of education was .47 (.51 for females and .45 for males). The partial correlation between spelling ability and years of education with age held constant was .29 (.31 for women and .29 for men). Thus, there is a significant relationship between spelling ability and years of education, even when age is accounted for.

Analysis of Unexpectedly Good and Poor Spellers

Male and female examinees were identified who (a) fell below the mean on spelling ability while being above the mean on English Vocabulary or (b) fell above the mean on spelling while being below the mean on English Vocabulary. These groups were thought of as (a) unexpectedly poor spellers and (b) unexpectedly good spellers. Differences between these groups on the standard battery tests and years of education were assessed, as well as relationships with handedness and parental handedness. Since clear sex differences in spelling ability were found, analyses were performed separately for males and females. The results are presented in Table 17 for selected measures.

No relationships with examinee or parental handedness were found. Significant differences were found on several tests and years of education (see Table 17). For both men and women, unexpectedly good spellers had significantly higher scores on Number Checking (graphoria) than unexpectedly poor spellers. Men who were unexpectedly good spellers also had significantly higher scores on Silograms, Number Memory, and Number Series. Thus, beyond general verbal facility, spelling seems to be related to perceptual speed and accuracy for both men and women and to several other aptitudes for men, also.

To further examine the relationships between the standard battery tests and spelling independent of English Vocabulary, partial correlations were calculated, controlling for English Vocabulary and age for males and females. For males, the following two significant ($p < .01$) relationships were found with spelling: Tonal Memory (.33), and Observation (-.30). For females, the following significant relationships were found: Number Checking (.31), Silograms (.22), and Number Series (.18).

Table 17

Differences Between Unexpectedly Good and Poor Spellers

Measure	Good spellers		Poor spellers		t	Effect size[a]
	Mean	*SD*	Mean	*SD*		
Women						
Number Checking	171.33	31.39	147.79	18.20	3.98**	.81
Reading Efficiency	24.56	5.56	27.19	5.65	2.15*	.40
Years of education	13.88	1.91	15.74	1.63	4.56**	.70
Men						
Number Checking	143.72	25.65	131.76	25.00	2.56*	.41
Ideaphoria	252.91	54.48	283.02	75.94	2.40*	.42
Silograms	20.17	8.66	14.31	9.16	3.59**	.61
Number Memory	83.94	28.95	71.93	27.77	2.30*	.42
Number Series	24.73	3.77	22.84	4.84	4.21*	.42
Reading Efficiency	22.87	6.38	26.02	5.69	2.78**	.48
Years of education	13.02	2.24	15.42	2.32	5.74**	.90

Note. *Ns* for women who were good and poor spellers were 39-40 and 34-36, respectively; *Ns* for men who were good and poor spellers were 63-64 and 51-55.

[a]This index is Cohen's (1988) *d*, which is the difference between the two group means divided by the pooled within-group standard deviation.

*$p < .05$. **$p < .01$.

SUMMARY AND DISCUSSION

After item deletion, the reliability of the 90-item spelling ability test was .92, which is very good. The items fit a unidimensional model fairly well, as evidenced by results of the factor analysis and the Rasch analysis. Also, the results of analyses of various subgroups (divided by age, sex, and so forth) resulted in similar orderings of item difficulties. This implies that the test measures spelling ability effectively and consistently across various examinee characteristics.

The distribution of spelling scores was approximately normal. This 90-item test could be improved for good spellers by the addition of more difficult items. This could provide a more-precise measure for highly skilled spellers and adjust the slight negative skewness of the distribution. The test, in its current state, can certainly be used with confidence when the Foundation needs to measure an examinee's spelling ability. In fact, if a placement test were used, abbreviated versions of the spelling test could be given to persons who score low, moderate, and high on the placement test. This added test construction effort may, however, not currently be worthwhile. The addition of difficult spelling items is somewhat problematic in the multiple-choice format because, no matter how hard a word is, about 25% of the examinees can choose the correct answer just by random guessing.

The correlations among spelling ability, spelling vocabulary, word familiarity, and English Vocabulary were all high or moderate in magnitude. Spelling correlated .82 (disattenuated) with English Vocabulary. These results suggest that spelling cannot be considered to be a skill separate from knowledge of word meanings. The relationship between spelling and age is similar to that between English Vocabulary and age. Spelling, therefore, seems to be an acquired body of knowledge, like vocabulary, rather than a distinct aptitude. It is likely that, for most persons, spelling and vocabulary knowledge are acquired together in the process of learning words.

Learning English spellings may be facilitated by the possession of certain aptitudes. When English Vocabulary was partialled out of the relationships between spelling and the standard battery tests, significant correlations were still found, notably with Number Checking (.31 for females and .34 for males). The analyses of unexpectedly good and poor spellers also suggested that graphoria plays a part in spelling success. In this respect, spelling appears to differ from English Vocabulary as a body of knowledge.

Females performed considerably better on the spelling test than males. There is some slight evidence that the relationships between spelling and the standard battery tests differ for males

and females, although the differences did not come in the major predictors in the regression or the first factors in the factor analyses. The relationships between spelling ability and age and education were stronger for females than males. Spelling ability for males showed a modest relationship with structural visualization; spelling ability for females was associated with vocabulary and graphoria and little else.

Little support was found for relationships between spelling and handedness, eyedness, parental handedness, and the interaction of examinee and parental handedness.

In conclusion, the new spelling test possesses superior psychometric qualities for future use. Spelling ability appears to reflect an acquired body of knowledge rather than an aptitude, although graphoria and possibly memory may play a part in the acquisition of this knowledge.

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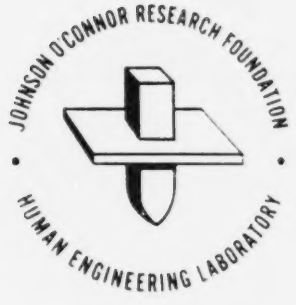
[1]This section lists references regarding spelling ability that were not cited specifically in the text of this report.



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